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Tidal energy effects of dark matter halos on early-type galaxies.

Valentinuzzi T., Caimmi R., D'Onofrio, M.

Abstract

Tidal interactions between neighboring objects span across the whole admissible range of lengths in nature: from, say, atoms to clusters of galaxies i.e. from micro to macrocosms. According to current cosmological theories, galaxies are embedded within massive non-baryonic dark matter (DM) halos, which affects their formation and evolution. It is therefore highly rewarding to understand the role of tidal interaction between the dark and luminous matter in galaxies. The current investigation is devoted to Early-Type Galaxies (ETGs), looking in particular at the possibility of establishing whether the tidal interaction of the DM halo with the luminous baryonic component may be at the origin of the so-called "tilt" of the Fundamental Plane (FP). The extension of the tensor virial theorem to two-component matter distributions implies the calculation of the self potential energy due to a selected subsystem, and the tidal potential energy induced by the other one. The additional assumption of homeoidally striated density profiles allows analytical expressions of the results for some cases of astrophysical interest. The current investigation raises from the fact that the profile of the (self + tidal) potential energy of the inner component shows maxima and minima, suggesting the possible existence of preferential scales for the virialized structure, i.e. a viable explanation of the so called "tilt" of the FP. It is found that configurations related to the maxima do not suffice, by themselves, to interpret the FP tilt, and some other relation has to be looked for.

1 Introduction

According to current cosmological theories, about 85% of existing mass in the universe is in the form of (non baryonic) dark matter (hereafter quoted as DM), whose tidal energy effects on the embedded (baryonic) matter could be large. Since the first evidence of DM presence in galaxy clusters (e.g., Zwicky, 1933), the existence of massive, non baryonic halos is consistent with present-day CMB surveys, large scale galaxy clusters studies, and necessary, e.g., for a viable explanation of flat rotation curves well outside visible disks of spiral galaxies (for an exhaustive review on DM refer to, Freeman and McNamara, 2006). The current investigation aims to provide further insight on the tidal action induced by massive halos on hosted galaxies, taking into consideration special sequences of two-component systems, intended to model early-type galaxies (hereafter quoted as ETGs) and their hosting halos.

The idea of exploring two-component systems, a stellar spheroid completely embedded in a DM halo, moves from the fact that the virial potential energy (hereafter

quoted as VPE) of the stellar component, shows a non-monotonic trend as a function of the radius, as opposed to one-component systems. This behavior is induced by the DM halo tidal potential, and is more effective for shallower DM halo density profiles. The occurrence of extremum points in potential energy could be highly rewarding, as in mechanics they correspond to stationary points and may be special configurations for the system. These extremum points could be a key to the explanation of the so called “tilt” of the Fundamental Plane (FP) (see, Bender et al., 1992).

The current investigation is based on two ETGs density profiles of astrophysical interest, using the formalism of the two-component virial theorem for an explicit expression of the VPE of the stellar subsystem embedded in the DM halo. The models and related special sequences of two-component systems, intended to represent ETGs, are defined in Section 2. An analysis of VPE extremum points, with the further restriction of energy conservation, is performed and discussed in Section 3. Comparisons between model predictions and both data from observations and results from computer simulations, are made in Section 4. Conclusions are drawn in Section 5.

The complete article is part of the book entitled **Energy Research Developments: Tidal Energy, Energy Efficiency and Solar Energy**, published by NOVA PUBLISHERS, and is available through the following web site: *https://www.novapublishers.com/catalog/product_info.php?products_id=7980*.

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